Agriculture and
Agri-Food Canada

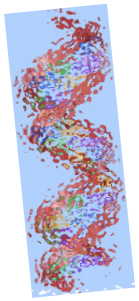
Genome and Metagenomics Analyses of *Clavibacter nebraskensis*, the Goss's wilt Bacterial Pathogen of Corn

James T. Tambong
Agriculture and Agri-Food Canada, Ottawa, Canada

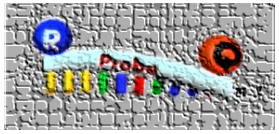
USDA-AAFC joint meeting, Cleveland, OHIO, August 03, 2019

Studying High Risk Plant Pathogenic Bacteria: What We Do and How?

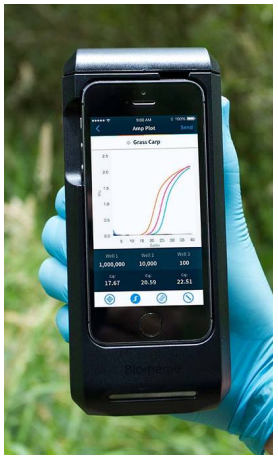
- ❑ Classical techniques



- ❑ MLSA
- ❑ Genome & Metagenomics analyses



- ❑ Fluorescent probe-based high-throughput & portable detection tools.



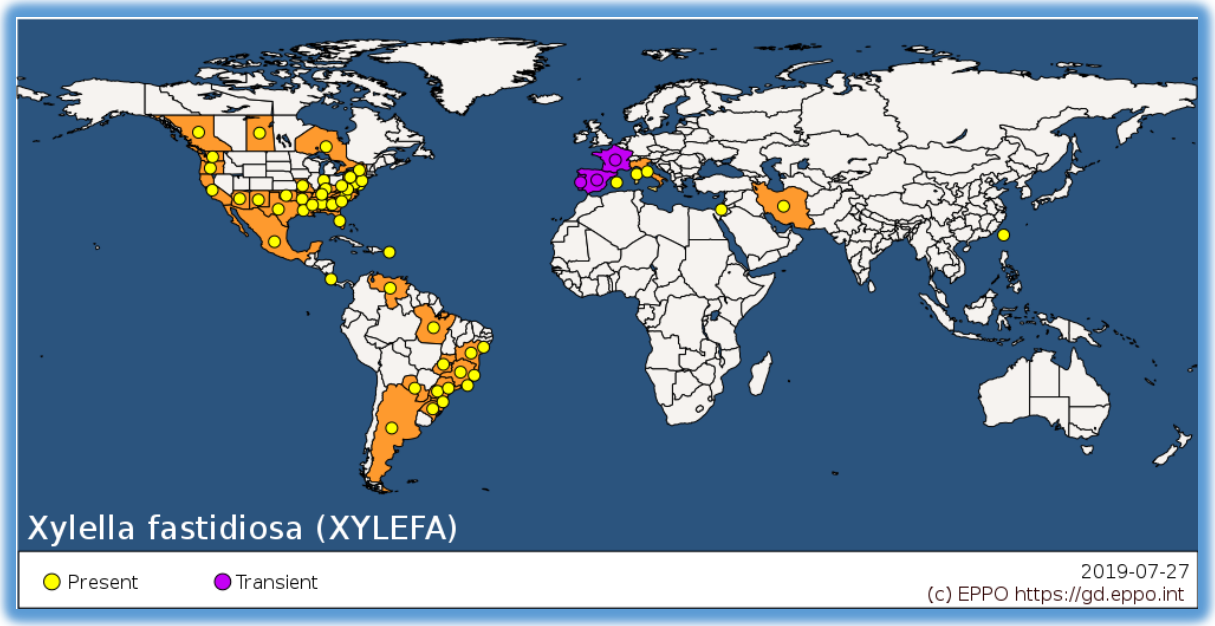
Population monitoring → **Systematics/ Taxonomy** → **Phylogeny/ Phylogenomics** → **Identification & Detection**

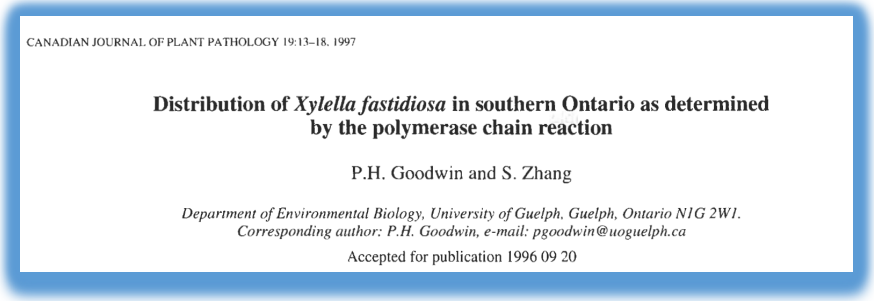
CFIA-Regulated bacteria

- **One of the high-risk pathogens regulated by CFIA is *Xylella* fastidiosa.**

- **The bacterium *Xylella fastidiosa* can infect over 360 agricultural and horticultural plant species.**

Pierce's disease on grapevines.





CANADIAN JOURNAL OF PLANT PATHOLOGY 19:13–18. 1997

Distribution of *Xylella fastidiosa* in southern Ontario as determined by the polymerase chain reaction

P.H. Goodwin and S. Zhang

Department of Environmental Biology, University of Guelph, Guelph, Ontario N1G 2W1.
Corresponding author: P.H. Goodwin, e-mail: pgoodwin@uoguelph.ca

Accepted for publication 1996 09 20

Economic Impacts of Xylella

Economic impacts

Xylella fastidiosa subsp. *fastidiosa*, the causal agent of Pierce's disease, has been a major constraint for grapevine production in the USA for more than 100 years, causing considerable losses. *Xylella fastidiosa* costs California US$ 104 million per year in terms of losses of vines and measures for disease prevention.

PLOS ONE

RESEARCH ARTICLE

Comparative genomics of *Clavibacter michiganensis* subspecies, pathogens of important agricultural crops

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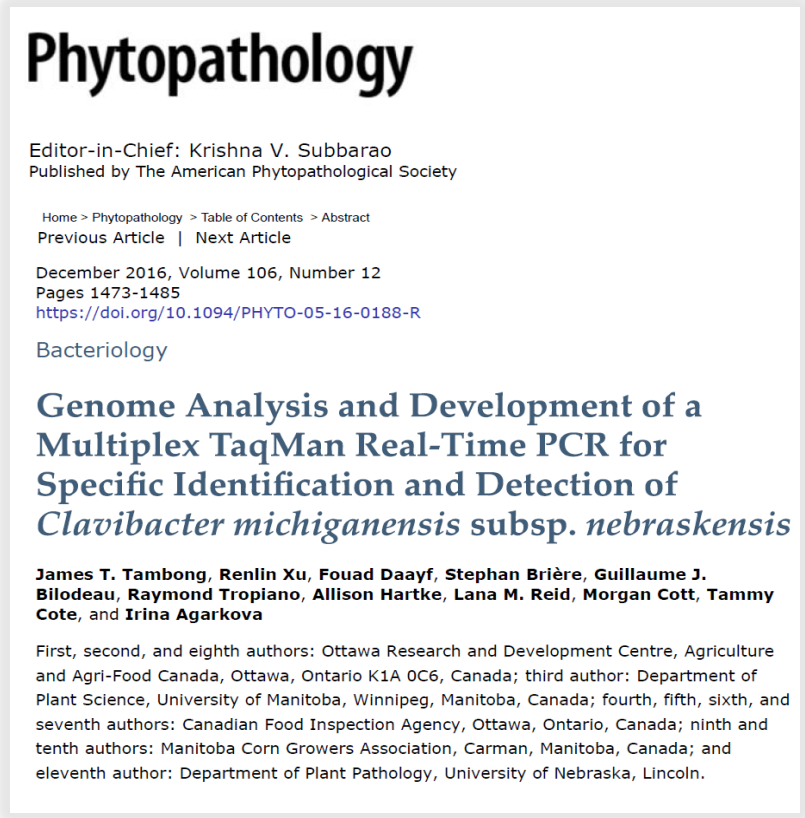
Genome analysis of the Goss's bacterial wilt pathogen



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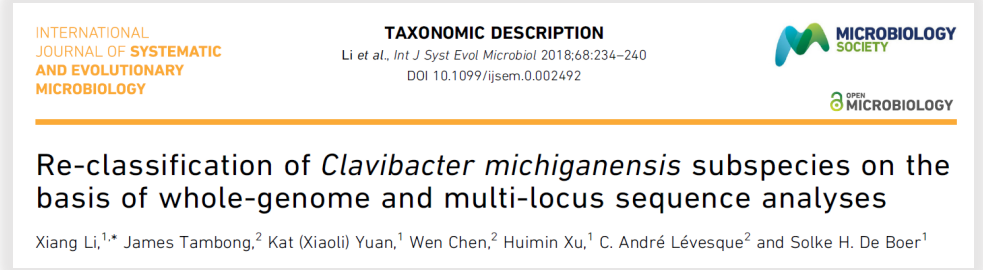
Bacteriology

Genome Analysis and Development of a Multiplex TaqMan Real-Time PCR for Specific Identification and Detection of *Clavibacter michiganensis* subsp. *nebraskensis*

James T. Tambong, **Renlin Xu**, **Fouad Daayf**, **Stephan Brière**, **Guillaume J. Bilodeau**, **Raymond Tropiano**, **Allison Hartke**, **Lana M. Reid**, **Morgan Cott**, **Tammy Cote**, and **Irina Agarkova**

First, second, and eighth authors: Ottawa Research and Development Centre, Agriculture and Agri-Food Canada, Ottawa, Ontario K1A 0C6, Canada; third author: Department of Plant Science, University of Manitoba, Winnipeg, Manitoba, Canada; fourth, fifth, sixth, and seventh authors: Canadian Food Inspection Agency, Ottawa, Ontario, Canada; ninth and tenth authors: Manitoba Corn Growers Association, Carman, Manitoba, Canada; and eleventh author: Department of Plant Pathology, University of Nebraska, Lincoln.



INTERNATIONAL JOURNAL OF SYSTEMATIC AND EVOLUTIONARY MICROBIOLOGY

TAXONOMIC DESCRIPTION
Li *et al.*, *Int J Syst Evol Microbiol* 2018;68:234–240
DOI 10.1099/ijsem.0.002492

MICROBIOLOGY SOCIETY

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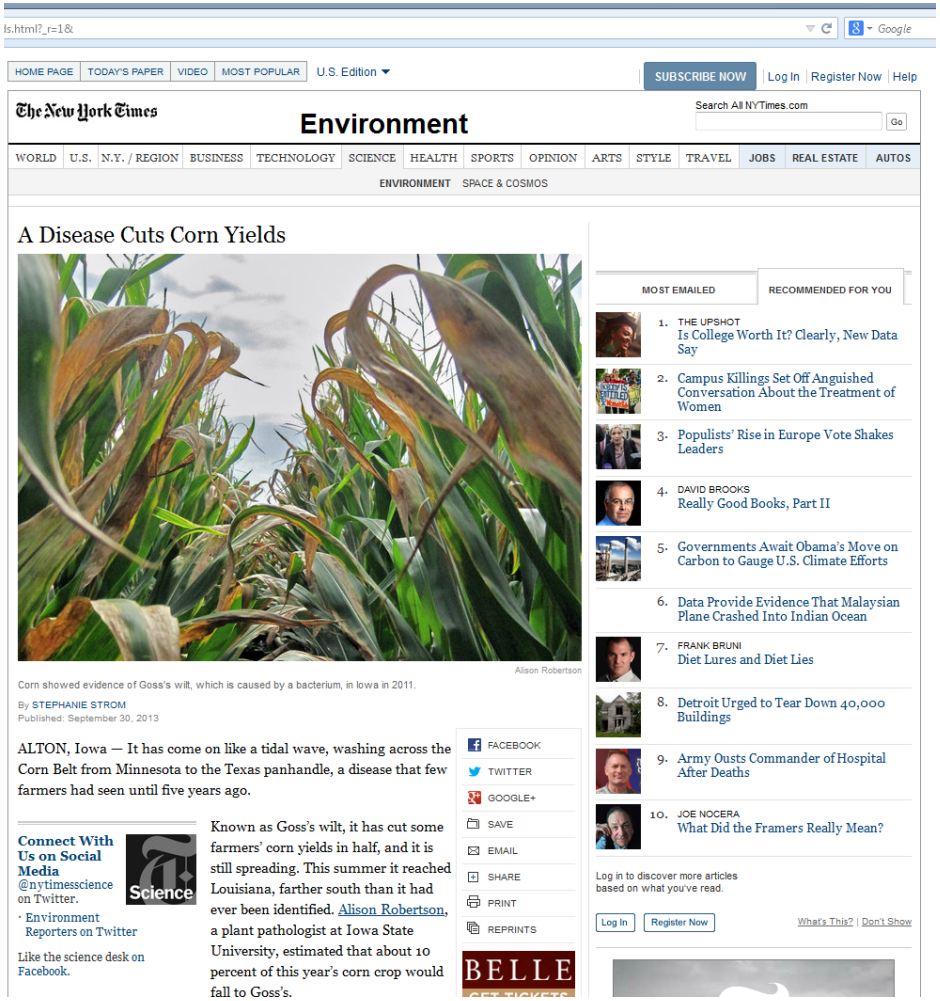
Re-classification of *Clavibacter michiganensis* subspecies on the basis of whole-genome and multi-locus sequence analyses

Xiang Li,[1,*] James Tambong,[2] Kat (Xiaoli) Yuan,[1] Wen Chen,[2] Huimin Xu,[1] C. André Lévesque[2] and Solke H. De Boer[1]

What made the Disease “famous”?

New York Times and the Goss’s wilt disease of Corn?



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A Disease Cuts Corn Yields

Alison Robertson

Corn showed evidence of Goss's wilt, which is caused by a bacterium, in Iowa in 2011.

By STEPHANIE STROM
Published: September 30, 2013

ALTON, Iowa — It has come on like a tidal wave, washing across the Corn Belt from Minnesota to the Texas panhandle, a disease that few farmers had seen until five years ago.

Known as Goss's wilt, it has cut some farmers' corn yields in half, and it is still spreading. This summer it reached Louisiana, farther south than it had ever been identified. Alison Robertson, a plant pathologist at Iowa State University, estimated that about 10 percent of this year's corn crop would fall to Goss's.

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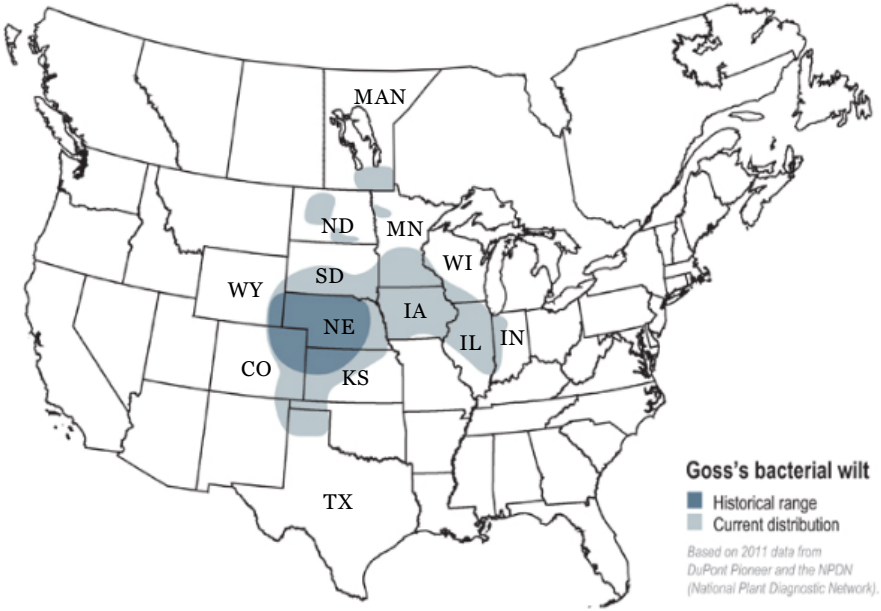
BELLE

“No one is certain why Goss’s wilt has become so rampant in recent years” Stephanie Storm wrote.

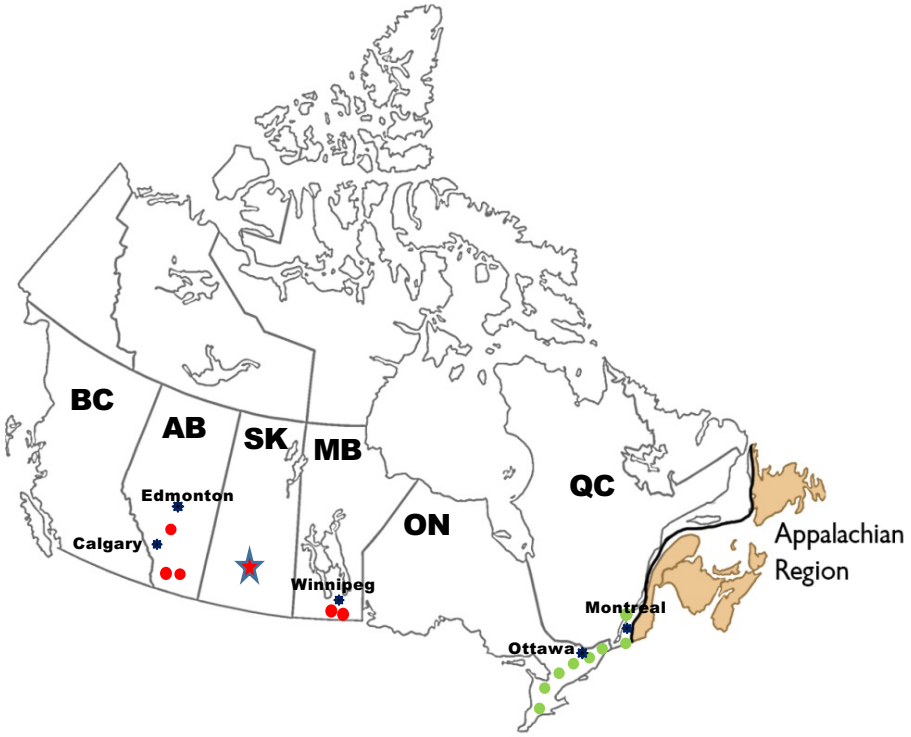
(The New York Times by Stephanie Strom, published: September 30, 2013)

- **Its re-emergence and rapid spread.**

Distribution of GWD: Historical and Current



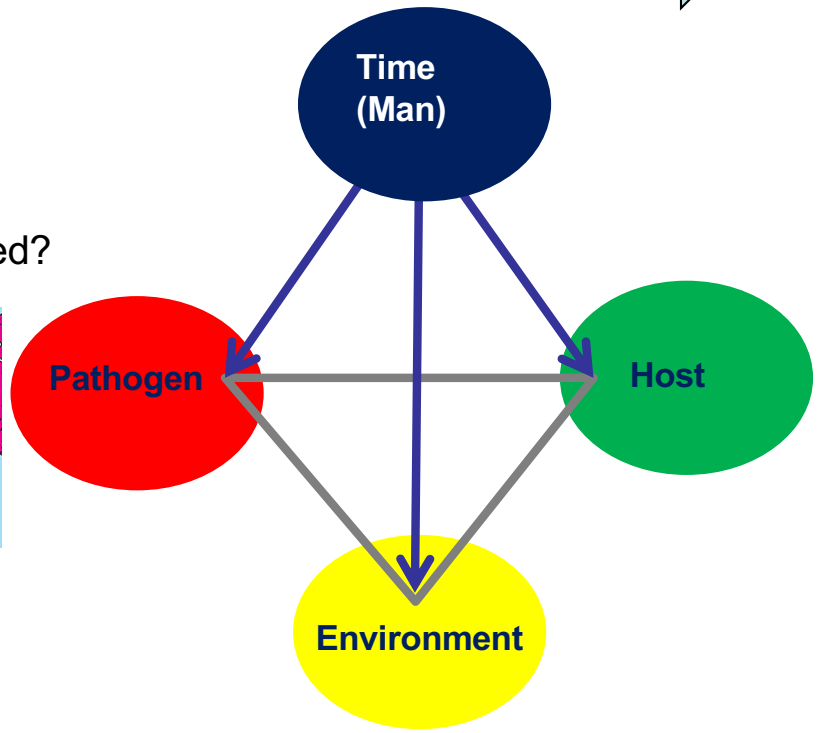
http://farmindustrynews.com/biotech-traits/growers-should-have-gosss-wilt-radar



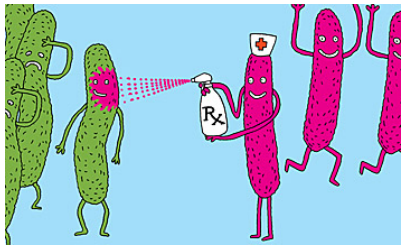
Source: Harding et al. (2018)

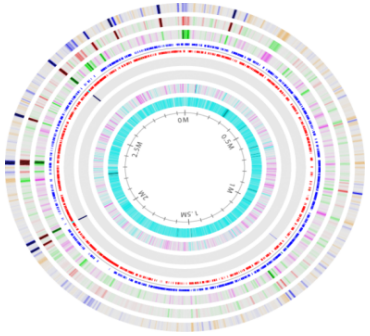
Why re-emergence and rapid spread of GWD?

Year 1969 → 50 years → Year 2019

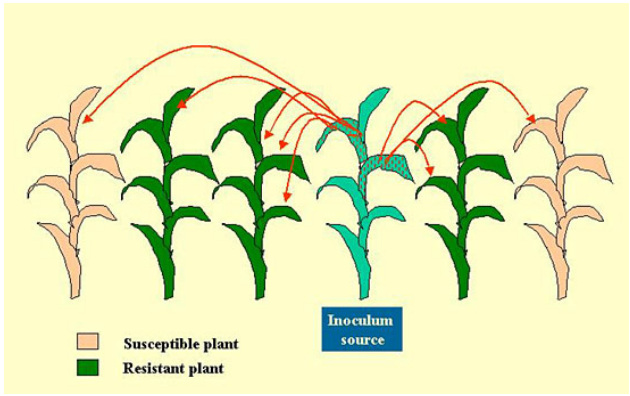


- Genetically changed?





- Wind patterns
- Rainfall
- Temperature
- Humidity

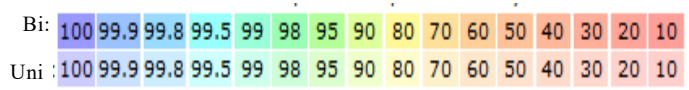


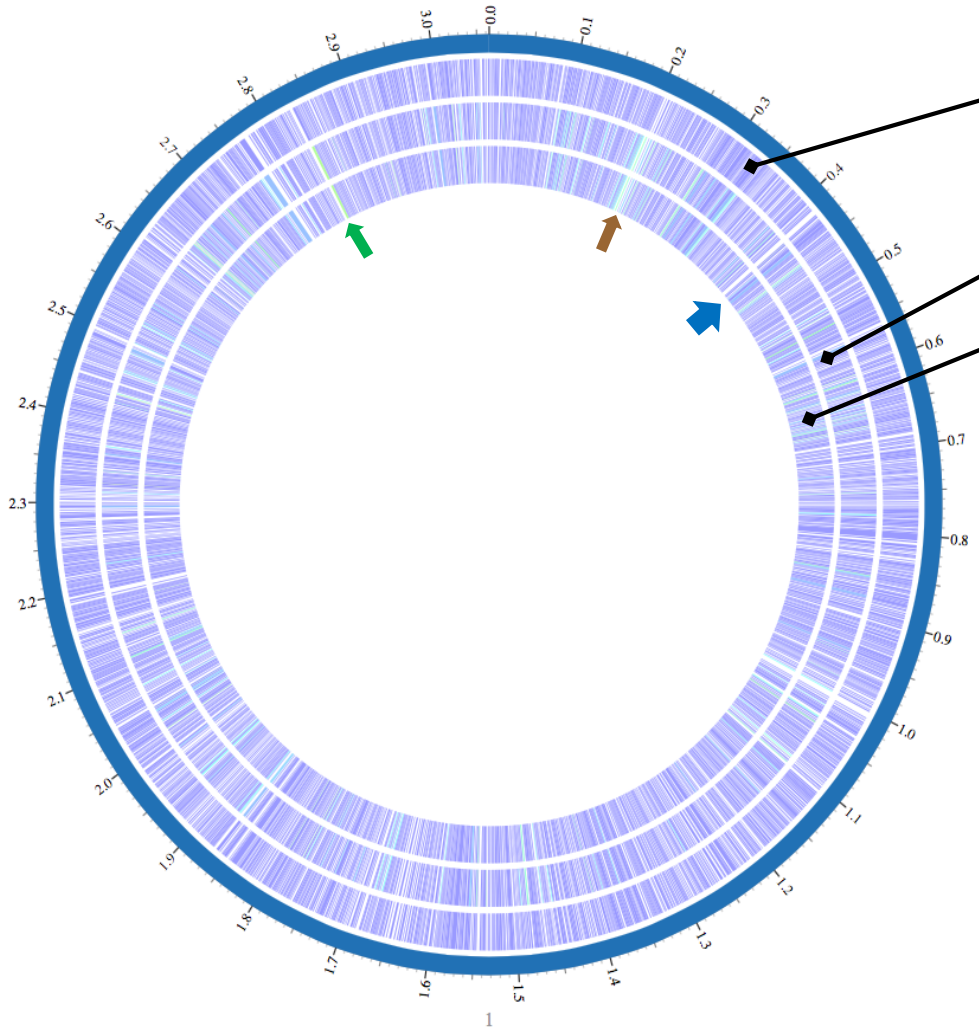
Substitution of resistant varieties for high yielding susceptible cultivars

Basic Disease Pyramid

Has the GWD pathogen changed?

Proteome similarities between DOAB395 and DOAB397 to NCPPB 2581 (type strain)





Strain NCPPB 2581 (1972)

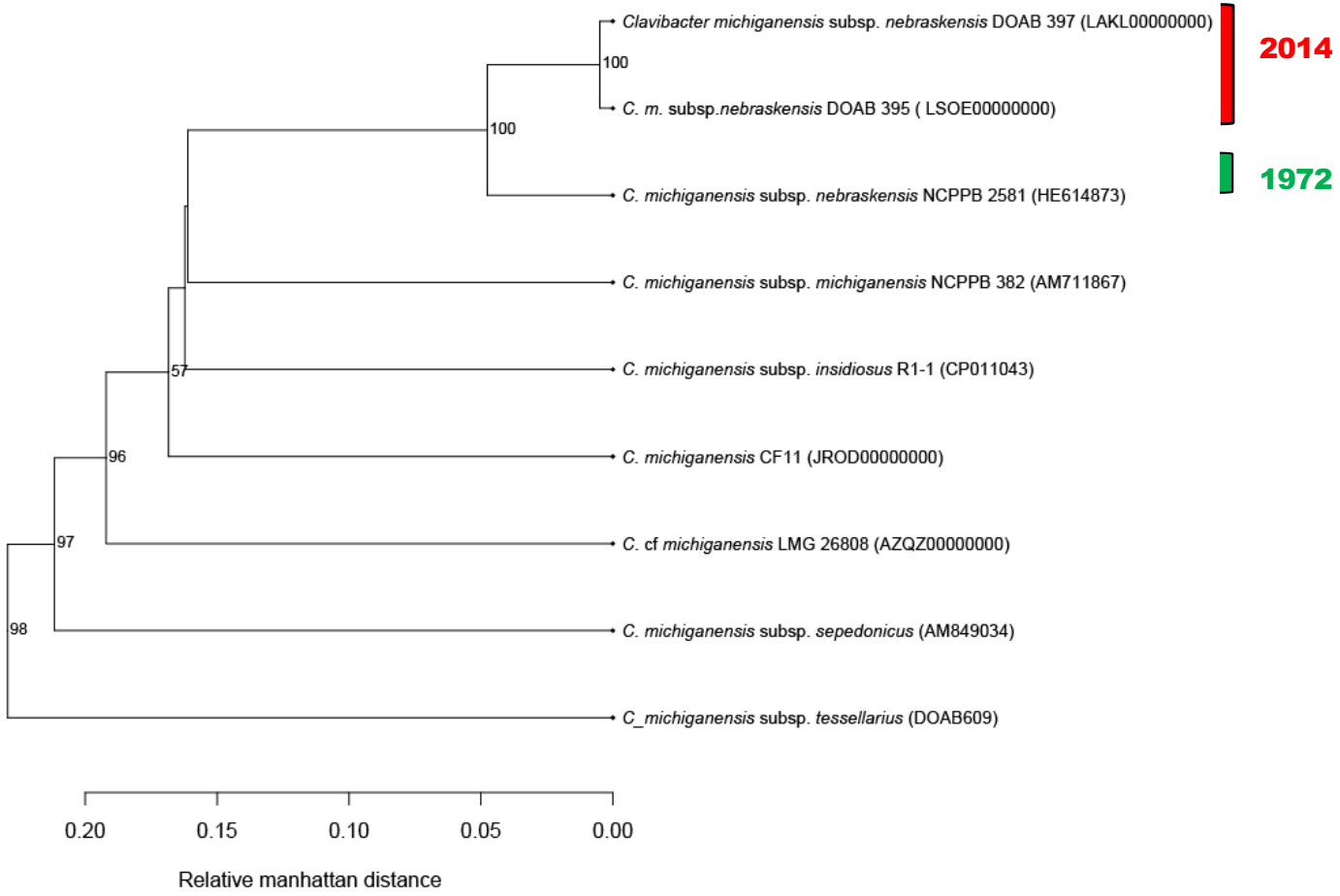
Strain DOAB 397 (2014)

Strain DOAB 395 (2014)

BLAST similarities

	DOAB 397	DOAB 395
NCPPB 2581	91.80%	92.10%
DOAB 397		99.20%

Pan-genome phylogenetic tree



- **Conclusion: The 2014 Cn strains have changed genetically and should be incorporated in corn breeding programs**

Nanopore-based Metagenomics analysis of Cn-infected corn leaves

Healthy

Cn-infected

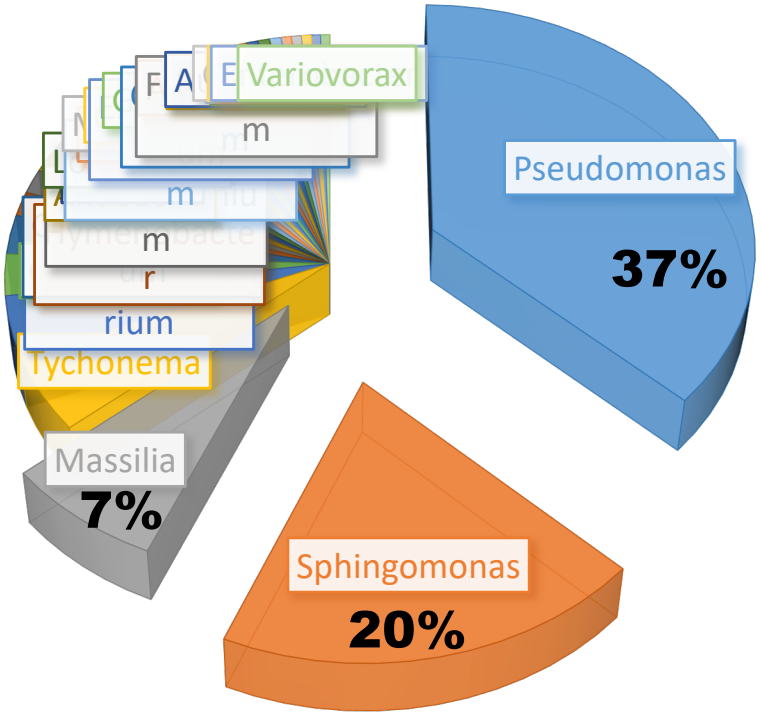
Nanopore reagents

Nanopore device

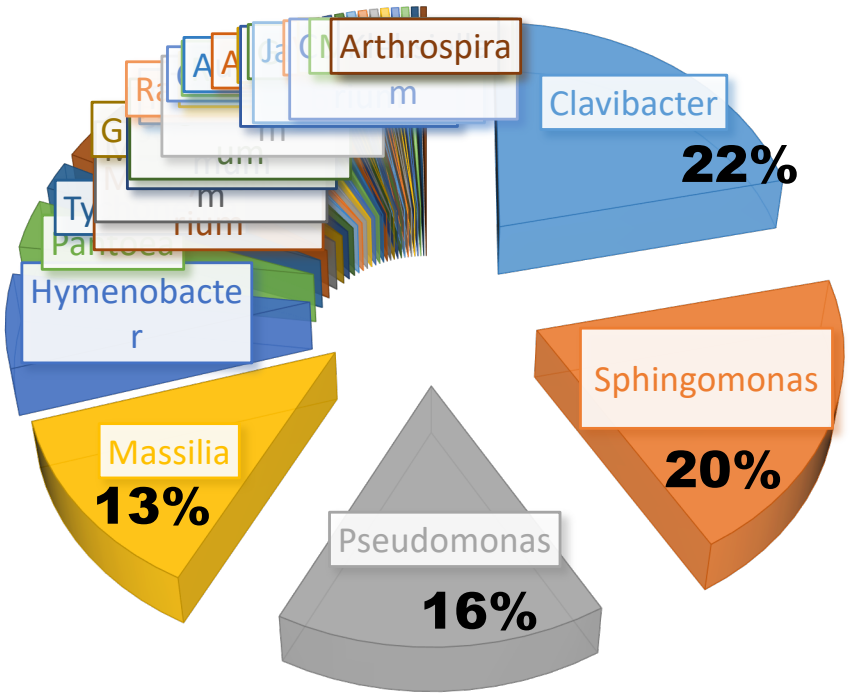
Loading sample & Sequencing

Nanopore-based metagenomics data reveal a Pseudomonas-Clavibacter population shift in Cn-infected leaves.

Healthy field corn leaves



Field infected corn leaves



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Agriculture and Agri-Food Canada

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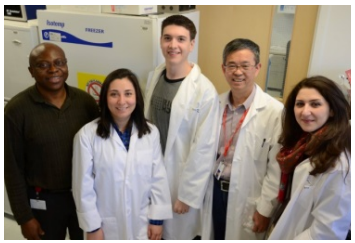
UNIVERSITY OF MANITOBA

Alberta Ministry of Agriculture and Forestry

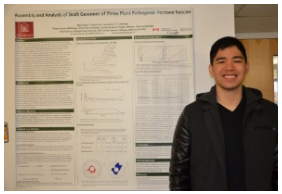
Supports the growth, diversification and sustainability of Alberta's agriculture and forest industries.

University of Georgia, USA



James, Maria, Loius, Renlin & Shima

Nicole, Harini & Sean



Kyle

- **University of Manitoba**: Dr. Fouad Daayf, Lorne Adam, Mohamed Atta and students
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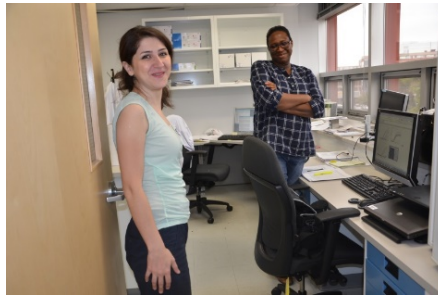
- Alberta Ministry of Agriculture and Forestry: Dr. M. Harding



Shima & Aissata

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Thank you / Merci!!!